Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

43
63
p.4

LIBRARY
CURRENT SERIAL RECORD
★ APR 2 6 1955 ★
U. S. DEPARTMENT OF AGRICULTURE

Recombined Milk

A Dependable Supply of Fluid Milk Far from the Cow

Foreign Agriculture Report No. 84

U. S. DEPARTMENT OF AGRICULTURE
Foreign Agricultural Service

ERRATA

RECOMBINED MILK
A Dependable Supply of Fluid
Milk Far From the Cow

Foreign Agriculture Report No. 84,
U. S. Department of Agriculture

Inside front cover: March 1955
Page 15, Table 1: Under Salt, Kilograms should read Grams.

CONTENTS

Page

Introduction 1
What milk can do for man 2
Technology extends the milkshed 3
Recombining the milk components: Questions and answers:
  What is recombined milk? 4
  It's still milk; still perishable? 4
  What equipment is needed? 5
    For recombining 5
    For ice cream 6
  What about plant layout? 6
  What about plant sanitation? 7
  What can the plant produce? 7
  How can the market be developed? 9
  How can the project be financed? 10
  Can a supply of dairy ingredients be assured? ... 11
  What about technical assistance? 12
  Does recombining affect a local dairy industry? 12
  Can it be done on a small scale? 13

Appendix:

I. Some technical pointers 14
II. Instructions for preparation:
  Skim milk 14
  Whole milk 17
  Chocolate skim milk, chocolate milk 17
  Ice cream 17
III. Approximate cost of plant installations 18

In the preparation of this pamphlet, the authors have had the assistance of the Dairy Export Advisory Committee, the Dairy Industries Supply Association, and Dairy Industries Society, International.

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. Price 15 cents

RECOMBINED MILK:

A Dependable Supply of Fluid Milk Far from the Cow

By D. R. Strobel and C. J. Babcock[1]

People in areas without a dairy industry sufficiently developed to meet their needs can get fluid milk today because science has learned to do these two things: To take milk apart so that the solid components can be shipped without refrigeration, and to put milk together again, into a product that cannot be distinguished from fresh fluid milk.

That product is recombined milk, made from dry skim milk and anhydrous milk fat (frequently called butter oil).

---

[1] Mr. Strobel is Marketing Specialist and Mr. Babcock is Chief, Foreign Marketing Branch, Livestock and Livestock Products Division, Foreign Agricultural Service, U. S. Department of Agriculture.

INTRODUCTION

Milk has come down to the modern world from the very cradle of civilization. Wherever there was grass (except in the Western Hemisphere), wherever man began to tire of depending upon the bow and arrow for his food supply, he began to milk the animals at hand--cows, buffaloes, sheep, goats, reindeer, camels. Early chronicles are full of references to "lands of milk and honey." Early buildings carried friezes of men milking domesticated animals. And for many primitive peoples the cow was the symbol of wealth, the unit of money.

Milk was prized just as it came from the animal; it was prized, too, in the many ingenious forms in which this perishable commodity was preserved--butter, ghee, cheese, yogurt, fermented drinks, even the cakes of dried milk that the Mongol soldier carried in his saddlebags. But as nomadic living turned into urban, as populations increased, milk became a forgotten blessing for most of the people in crowded lands; it was available only to those who lived in the country, or to rich folk as a luxury.

Only within the last hundred years or so has milk been traveling any great distance from the cow. First, as butter and cheese it was shipped from the rich pastures of Denmark and the Netherlands, France and Switzerland, Australia and New Zealand; then evaporated and condensed milk were introduced; and finally technicians discovered how, by careful safeguarding through pasteurization and refrigeration, milk could safely appear upon dining tables hundreds of miles from the green pastures. And now, modern technology has extended these hundreds of miles of "milksheds" into the thousands; and this pamphlet has been prepared to give in technical detail the important facts about this new movement of milk across land and sea.

WHAT MILK CAN DO FOR MAN

In most lands, man has instinctively recognized that milk and its products bring health: that they add to man's stature, brighten his eye, and give him that sense of well-being which helps him to approach the problems of living both with energy and with serenity. It remained for the modern science of nutrition--a new science and one not yet complete--to analyze milk and lay out before the eyes of the world the various nutritional elements which make it so effective. Calcium develops the bones and helps in the building process; protein furnished the material out of which the body recreates itself; and milk fat and lactose give energy. Then there are the vitamins, especially riboflavin (vitamin B_2), and other growth factors, not all of them yet isolated, but all of them known by the beneficial effect of their presence in the diet of animals and human beings and by the disastrous effect of their omission. And further, we have the discovery that other foods contribute more to man's well being when they are used with milk.

According to the 1955 edition of Milk Facts--

> A quart of milk--4 glasses--supplies approximately these percentages of the daily nutritive requirements of an average man: calcium 100%; riboflavin 93%; phosphorous 61%; protein 49%; vitamin A 31%; thiamin (vitamin B_1) 23%; calories 22%; ascorbic acid 17%; niacin 7%; iron 5%.

In general, the tall peoples of the world are those that have a tradition of using milk and dairy products. Folklore and anthropology alike have shown us this in broad general ways. It remained for the modern nutritionists, again, to demonstrate the connection between milk and growth.

In England, in the 1920's, Dr. H. Cory Mann experimented with the diets of two groups of boys in an industrial school. To one group he gave a diet worked out to supply them, supposedly, with all the foods needed for health and growth. To the other group he gave the same diet--plus extra milk. At the end of 4 years, the boys in the first group had gained 1.8 inches in height. The milk drinkers, however, had not only grown 2.6 inches, but were more alert than the others, and showed superior gains in mental development.[2]

In Japan, the youngsters receiving milk in their school lunches increased 88 percent more in weight and 16 percent more in height during 6 months than did their schoolfellows who did not receive milk.[3]

Many authorities could be cited and many volumes recommended for reading on this important matter of introducing milk into the diet. This pamphlet is concerned primarily with techniques and mechanisms for getting milk into areas where there is not now a dairy industry sufficiently developed to meet the nutritional needs of the peoples of the area.

---

[2] Sealtest Consumer Service, *Milk, Nature's Most Perfect Food*, New York, 1950.

[3] *Ibid.*

TECHNOLOGY EXTENDS THE MILKSHED

In geography, the whole area contributing to the water supply of a river is known as a watershed. Similarly, the dairy people have come to speak of the whole area supplying fresh milk to a particular market as the "milkshed" for that area. For many cities of the United States and Canada, this milkshed often extends hundreds of miles: New York City reaches out some 700 miles daily for part of its fluid milk, and Philadelphia almost as far. In India, Bombay gets some of its fresh pasteurized milk from pastures near Anand, 300 miles away.

This long reach has been made possible by modern techniques for handling fresh fluid milk, a highly perishable food. From proper housing of cows, sanitary practices on the farm, quick cooling of the milk, and protection from contamination by flies, dirt, and human beings comes a good-quality milk. This milk is rushed in refrigerated or insulated trucks to the processing plant. Here the milk is promptly and carefully handled, pasteurized, cooled, and packaged in sanitary containers; then, protection during delivery and proper refrigeration during storage can bring to the consumer a safe, fresh product of excellent quality. Where these techniques have been developed, the habit of drinking milk has spread from the farm to the city, supplementing the traditional use of less perishable dairy products in the diet.

These improved techniques of handling fluid milk and cream are of comparatively recent development; milk pasteurizing was first attempted just before the turn of the 20th century.[4] Even earlier, other methods of extending the usable life of milk had been developing. Among these were condensing and evaporating; and drying, too, finally became practicable--a long time after the followers of Genghis Khan had used dry milk as battle rations.

Experience has proved that dry milk, if protected from moisture, can be shipped without refrigeration and has a relatively long "shelf life." Dry whole milk keeps reasonably well, but dry skim milk (nonfat dry milk solids)[5] keeps excellently. Butterfat, too, can be shipped and stored without refrigeration, if packed in airtight containers. But first the moisture must be wrung out as it is by the peoples of Asia who boil down their butter to make ghee. If moisture is removed under milk plant conditions, the resulting product is anhydrous milk fat, frequently called butter oil, which contains a minimum of 99.8 percent butterfat.

---

[4] H. Weigman (Director of the Dairy and Bacteriological Division of the Kiel Experiment Station), Methods of Milk Conservation, published for the Dairy Association, 1893.

[5] By U. S. law, nonfat dry milk solids contain not more than 5 percent moisture. In accordance with U. S. quality standards for this product, U. S. Extra grade contains not more than 4 percent moisture and not more than 1.25 percent butterfat.

RECOMBINING THE MILK COMPONENTS: QUESTIONS AND ANSWERS

What is Recombined Milk?

In the development of dry skim milk, it was discovered that water would mix readily with the low-heat product made by the spray process (where fine particles of milk are sprayed into a heated stainless steel chamber and dried as they float down through the air). Good-quality powder, if blended under milk plant conditions and given a chance to stand for a time at refrigeration temperatures (35° to 40° F.), has the same flavor as fresh skim milk. But this product, useful as it is, is still not whole milk. So techniques have been developed by which anhydrous milk fat may be added under proper conditions to produce a product scarcely distinguishable from fresh pasteurized whole milk.

Plants in Mexico and in the Far East are now successfully recombining milk on a large scale. Where the proper precautions are observed, where the ingredients are of good quality, where the water supply is properly treated to free it from odors and undesirable flavors, and where the finished product receives all the safeguards given fresh fluid milk, the results are excellent.

It's Still Milk--Still Perishable?

Skim milk powder does not normally require refrigeration in its dry state; neither does anhydrous milk fat unless stored under hot-weather conditions for more than 2 months. But once these components have been recombined with water, the finished product requires all the safeguards given fresh milk to insure retention of the flavor and of the nutritional factors. This means that plant recombining of milk calls for not only the proper ingredients, properly manufactured and properly handled during shipment and storage; not only the mechanisms for mixing and blending; but also the facilities for pasteurizing and cooling the product, for bottling it under sanitary conditions, and for safeguarding it during distribution. The plant must therefore have equipment for mixing, homogenizing, bottling, and refrigerating; facilities for cleaning and distribution; a laboratory; and an adequate supply of water for both recombining and cleaning operations.

The importance of a good, safe water supply must be stressed. In some places, this can be obtained with comparative ease, but in others, where minerals and other elements in the water leave an unfavorable imprint on the recombined dairy products and are hard to remove, a water treatment unit may be necessary to insure clean, odorless water to mix with the dry ingredients. Also to be stressed is the need for an adequate laboratory to determine if a product of proper composition and quality is being produced.

What Equipment Is Needed?

The size of equipment required, and in some cases the type of vat or pasteurizer desired, will depend on the size of the plant's operations and on how many hours a day the plant will be functioning. Certain basic equipment is necessary, and the following list is minimum, rather than all-inclusive.

For Recombining

1. Pasteuring Vat. Should be of stainless steel where in contact with the milk product, and should be equipped with an air space heater. Should be designed so that it can be readily drained and the product can be subjected to agitation until the vat is completely empty. The electric motors operating the agitators must be properly waterproofed in accordance with the 3A Sanitary Standards of the Dairy Industry, developed in the United States. Indicating and recording thermometers are desirable.
2. Homogenizer. Should be equipped with a sanitary head, and readily cleanable. Should also be in complete operating condition, with motor and starter controls.
3. Milk Cooler. May be either cabinet type or plate type, but should comply with the 3A Sanitary Standards applicable to such equipment.
4. Blender Pump. (For reconstituting.) Should have a funnel for adding the powder to the water as it flows into the pump. Should be of stainless steel throughout, and should comply with the applicable 3A Sanitary Standards.
5. Milk Pump, Regular Centrifugal. Should be of stainless steel and readily taken apart for proper cleaning.
6. Tanks, Level or Surge. (To provide an ample supply of milk ahead of the filling operation.) Should be of stainless steel where in contact with the product and need not be insulated.
7. Paper-Bottle Filler.[6] Should be sanitary; all parts in contact with the milk product should be of stainless steel and readily cleanable.
8. Cases for Paper-Bottled Milk. Can be metal or wood. Wood should be pressure-treated to prevent deterioration when exposed to moisture.
9. Paper Bottles. Should be made so that they can be properly waxed or treated with paraffin to prevent leakage and provide a nearly sterile package.
10. Wash Sink and Rack. Can be of galvanized metal or stainless steel, but should be large enough to accommodate the sanitary piping to be washed in this unit. The 10-foot unit with power turret should be equipped with a waterproof motor.
11. Platform Scale. (To be used for weighing the material to be reconstituted.) Should be noncorrodible metal.

---

[6] For equipment required for bottling in glass, see items 15 to 18.

12. Steam Generator or Boiler. Should have sufficient capacity to provide steam both for processing and for plant cleanup and sanitizing.

13. Refrigeration for Cooling Milk. May be any suitable unit producing 2,600 pounds of ice. Comprises refrigerant, compressors, condensers, receivers, and ice builders or chilled water units, depending upon the type of cooler used.

14. Refrigerated Storage. Should be a suitable knocked-down portable box, built of aluminum or suitable material outside and inside, with insulating material capable of maintaining a temperature of 35°F. inside with an outside temperature of 100°F.

15. Glass-Bottle Filler. Bowl should be of stainless steel with suitable control float for maintaining the proper level of milk. Filler should be adjustable to different sizes of bottles and equipped with a waterproof electric motor.

16. Bottle Washer. To insure clear, sanitary bottles, should be soaker type or spray type, of suitable capacity to meet the needs of the bottle filler.

17. Glass Bottles. Should be of standard design and of sizes usual in the area concerned.

18. Cases for Glass Bottles. Should be of wood and metal properly treated to prevent rotting and corrosion.

For Ice Cream

1. Refrigerated Storage. Should be a suitable knocked-down, portable box built of aluminum or suitable material outside and inside, with insulating material capable of maintaining a temperature of -20°F. to 0°F. inside with an outside temperature of 100°F.

2. Ice Cream Freezer, Batch. Should be a stainless steel batch freezer, preferably direct expansion.

3. Compressor for Ice Cream Freezer. Should be water-cooled, and of sufficient size to maintain proper freezing for a 40-quart-batch freezer.

4. Ice Cream Cup Filler. Should be automatic, with proper safety control; should be constructed of stainless steel.

5. Laboratory Equipment. Should be adequate to test fat content and total solids content and to run standard bacterial plate counts on the finished product.

What About Plant Layout?

Although the size of the building and the amount of milk produced will influence the final placing of equipment within the plant, the flow chart on page 8 shows in a general way how the product will travel through the plant.

In addition to the basic equipment outlined above, facilities must be provided for storing the dry ingredients before recombining. The space provided should be sufficiently large, and with protection from rats and other predatory animals or from insects. Refrigeration is not required, except for the anhydrous milk fat if this product is to be kept at extremely high temperatures for an extended period of time. It is important, however, that the storage area be as dry and cool as possible. Once the moisture-proof covering for the nonfat dry milk solids is penetrated, the product absorbs moisture and deteriorates rapidly, and must be used within a few days.

For details as to manufacturers of equipment, current prices, and proper size for operation contemplated, address:

Dairy Industries Supply Association
1108 16th St. NW.
Washington 6, D. C., U. S. A.

What About Plant Sanitation?

Plant sanitation means proper cleaning and sanitizing of all plant equipment; keeping the plant building and surroundings clean and free from insect and rodent infestations; and maintaining high standards of cleanliness and health among plant personnel.

All dairy equipment coming in contact with milk or milk products should be thoroughly rinsed with water prior to the use of a cleaning agent. After the rinsing, only cleaning agents specifically compounded for dairy plants should be used--not soap or soap products. Brushes, not rags, should be used to clean the equipment surfaces. After a thorough washing, the equipment should be rinsed with hot water. Equipment such as homogenizers and pumps should be completely taken apart for cleaning. Prior to its next use, the equipment should be sanitized with steam or a chemical sanitizing agent.

If a bottle washer is used, the strength of the cleaning solutions in the washer should be constantly checked and bacteria counts made on the bottles to determine that a thorough cleaning job is being done.

If a milkstone deposit appears on the equipment owing to the use of improper cleaning agents or methods, this deposit should be immediately removed with an acid cleaner.

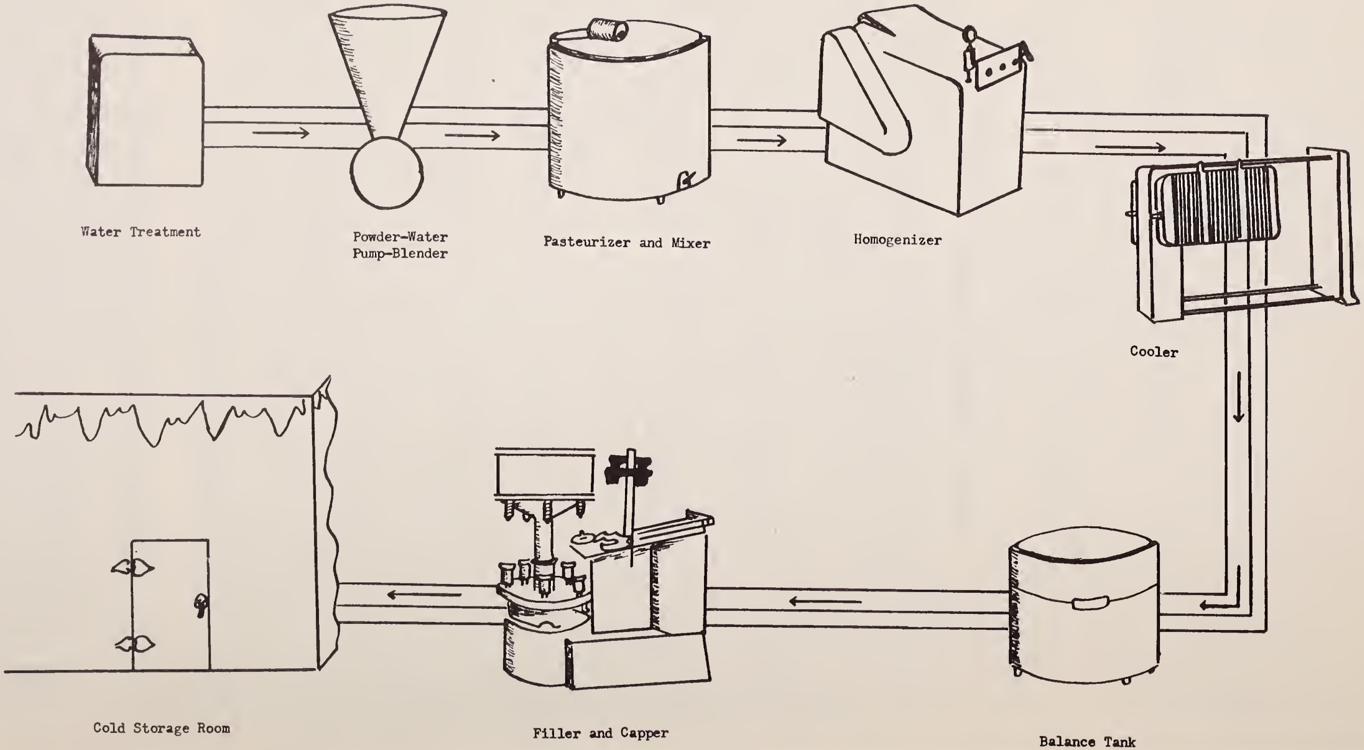
It is important to remember that if proper cleaning and plant sanitation methods are not followed, a finished product of high quality cannot be produced.

What Can the Plant Produce?

A recombining plant is not just a one-product operation. While the most striking achievement of the recombining process is the production of safe, palatable, fresh-tasting fluid milk and cream thousands of miles from the cows that gave the original milk, the plant output need not be confined to these two products. In general, the dairy products that

RECOMBINING PLANT

SUGGESTED FLOW CHART



can be effectively manufactured in a recombining plant are those that would normally be manufactured in a fresh milk plant for immediate use in the local markets. They will vary widely with the tastes of the public served.

Products that can be made in addition to recombined milk include--

buttermilk, chocolate milk drink, tropical-fruit milk drinks, coffee milk, skim milk

sour cream, table cream

ice cream, ice milk, sherbets

yogurt, cottage cheese

combination fluid milk ("toned"), made by blending local milk with recombined to step down the amount of butterfat in buffalo milk or to augment the local supply.

local fermented milk drinks

Formulas and instructions for mixing milks of various fat content and for making chocolate drinks, as well as for making ice cream from dry ingredients, are given in the Appendix (No. 1). Information on the equipment and techniques used in making buttermilk, cottage cheese, yogurt, and other cultured products can be obtained by writing to Dairy Industries Society, International, 1108 16th St., NW., Washington 6, D. C., U.S.A.

How Can the Market Be Developed?

Before undertaking the establishment of a recombining plant, an appraisal of the market potentials should be made. The mere fact that a food product is on the market does not mean that consumers will flock to buy it. On the other hand, the mere fact that there is not a clamoring market already in existence does not mean that one cannot be developed satisfactorily. Milk is not just milk. There is a vast difference between the consumer acceptance of high-quality milk and that of unsanitary, half-spoiled, unpalatable milk. The preference for high-quality milk is strikingly shown in Bombay, India, where under the Bombay Government's Milk Scheme a supply of wholesome, clean, fine-tasting milk is being produced. It can be obtained only under rationing, and the demand is such that there is a long waiting list of hopeful consumers. This preference was also shown in Hong Kong in the summer of 1954, when a new recombining plant reached and passed its capacity within 6 weeks, with a constantly increasing waiting list of customers. Men who have studied the nondairy areas of the world believe that a market for high-quality recombined milk can be developed.

The plan of action for market development must of necessity vary from region to region. There are, however, a few steps that would be applicable to almost any area.

. . . supply hotels and restaurants. In almost every part of the world, there is an increasing number of visitors from the milk-using countries of North America and Europe. (In Bombay, hotels and restaurants are forbidden to use the scarce local supplies).[7]

If milk from the recombining plant is served in the original containers, with proper emphasis upon the fact that it was processed in a modern, sanitary plant, there will be acceptance. No chances should be taken with contamination in the hotel kitchen through careless handling of the milk by employees who do not understand the necessity for sanitary precautions.

. . . deliver to the foreign colony or sell through the stores which it patronizes, again playing up in advertising the fact that this is wholesome milk, processed under modern conditions.

. . . in cooperation with leading educators, women's organizations, health officials, and so on, in the country concerned, establish a school lunch program as an effective way of demonstrating the benefits of milk in the diet and of establishing the milk-drinking habit among the young. Controlled demonstrations such as those outlined earlier can be undertaken to give a dramatic presentation of the growth and health factors in milk.

. . . supply hospitals, infant clinics, and health centers, working with doctors and nurses to make sure that both patients and families understand the need for milk in building health.

. . . introduce milk into factory worker feeding schemes, with demonstrations to show that the efficiency of the workers receiving milk increases beyond that of those not receiving it.

. . . take advantage of the taste for milk and milk products already developed through such relief organizations as UNICEF, CARE, and the various service and rehabilitation groups.

. . . develop a market for ice cream and related products. In many cities throughout the world, children pay a vast number of pennies for flavored water, which offers little nutrition. An ice cream or ice milk (lower fat content, but made with dairy products) of good flavor and of real nutritional value should find a ready market in almost every area.

How Can the Project Be Financed?

In developing a recombining enterprise, it is well to have a sound idea of what such an operation should cost. Because of the wide variations in shipping costs, in sizes of equipment required, in local conditions of installation, and in a number of other factors, it is impossible to give a definite figure on construction and equipment costs. There can only be signposts.

---

[7] U. S. Department of Agriculture, The Role of Recombined Milk and Butter Oil in the Export Distribution of Dairy Products, FAS Circular FD 9-54, Sept. 16, 1954.

These costs should be considered:

1. Land (depends on local conditions).
2. Water supply.
3. Construction of new building or adaptation of existing building (the latter is not recommended unless the building can readily be kept in top sanitary condition). Again local conditions dictate.
4. Equipment. Here only range can be given.
5. Conversion of existing milk plant to perform recombining operation.

Often, a combination of local and outside capital can be developed, particularly when it brings into partnership technical skills and a knowledge of local conditions. In many areas, governments are prepared to work together to aid in the development of such an enterprise. Under Public Law 480, passed in 1954, the United States Congress has authorized the President to confer with other governments in order to facilitate the development of enterprises that would absorb current agricultural surpluses and build up new markets for the future. Currency adjustment, the offering of surplus United States dairy products at world market prices, and the exchange of technical information are among the facets of this cooperation. Information as to the cooperation possible under this law can be obtained by consulting with the agricultural attaché of the United States, or by writing to the Foreign Agricultural Service, United States Department of Agriculture, Washington 25, D. C., U. S. A.

International banking organizations, such as the International Bank for Reconstruction and Development (World Bank) and the affiliated international lending agency dealing with loans for economic development, are often interested in such projects. The economic development organization in the country concerned should be consulted.

Can a Supply of Dairy Ingredients Be Assured?

The Foreign Agricultural Service of the United States Department of Agriculture and the Dairy Export Advisory Committee (appointed to give to this Service the benefit of its members' export experience in the dairy field) both believe that once markets are established, the cooperation engendered will continue and that from one part of the world or another the basic ingredients will be forthcoming for recombining and for the manufacture of dairy products that will follow. FAS officials expect not only the continuation but the increase of United States cooperation with the governments and the dairy industries of the other dairying countries of the world, as well as with international organizations devoted to dairy enterprise (such as Dairy Industries

Society, International; and the International Dairy Federation). In addition, the various United Nations agencies such as UNICEF, FAO, and WHO will undoubtedly continue to work for the channeling of the dairy products of the great dairying countries into the yet-to-be-developed markets of the countries where dairying is not practical or is still primitive.

What About Technical Assistance?

The importance of technical competence in the plant management and in at least a nucleus of the plant employees cannot be too greatly stressed. The processing of milk calls for knowledge and training, and no new operation can hope to become established on a sound basis without personnel of proved technical competence. Necessary also is knowledge of the nutritional possibilities of milk on the part of men in the marketing departments. It is recommended that initial operations be in the hands of experienced men trained in dairy techniques, and that inplant training be established to teach the local workers the fundamentals of sanitation and technical methods. Dairy enterprises set up in nondairying countries have found that the men in the plants quickly absorb this information, provided they are not only properly taught, but properly coached in the importance of careful operations.

In this training process, the Foreign Agricultural Service and the Foreign Operations Administration are equipped to be of assistance. There are competent technicians also in the United Nations entities such as FAO, UNICEF, and WHO; the regional organizations such as the Colombo Plan and the Organization of American States; industry groups such as Dairy Industries Society, International; and commercial firms specializing in the processing of dairy products. All these organizations are interested in the development of dairying and the dairy industries.

Programs of technical education are being worked out by these various organizations, more often than not in concert; and their local representatives should be consulted concerning possibilities for training key plant personnel abroad.

Does Recombining Affect a Local Dairy Industry?

The question is often asked, Does recombining ruin a local dairy industry? The answer, to judge by the record so far, is that the two work together to stimulate a real demand for milk and milk products. Plantwise, conversion from one to the other--fresh milk or recombined--is comparatively easy. Marketwise, there is little difference once a taste for milk is developed. In the wake of recombining there is invariably an added interest in the other dairy products--cheese, ice cream, butter. The spiral has been upward.

Can It Be Done on a Small Scale?

Equipment has been developed for recombining on a small scale, and research is being undertaken to perfect single small units that will perform many of the recombining functions. While such small-scale equipment is useful in the case of rehabilitation camps, refugee centers, and the like, it must be emphasized that the same needs apply as for large-scale operations--sanitation safeguards, pasteurization and quick cooling, and pure water. Consequently, the attendant electrical, heating, cooling, and water purification facilities must be available. Since an important part of the recombining process is homogenization to make sure that there is complete mixing of the ingredients, a small-scale unit would need to include homogenizing equipment as well as the pasteurizing facilities.

Where the problem is group feeding on a scale not large enough to warrant the purchase of recombining equipment, and where a joint project with other groups is not possible, it is recommended that only nonfat powder be used. Where possible, the powder may be supplemented in feeding by the use of butter or ghee. Proper sanitary procedures are also essential in handling the nonfat milk.

APPENDIX

I. Some Technical Pointers

The basic ingredients for recombined milk are low-heat spray-dried nonfat dry milk solids (dry skim milk) and anhydrous milk fat (approximately 99.8 percent pure milk fat). These ingredients when packaged in airtight containers do not require refrigeration. Unpublished data of the Agricultural Research Service, United States Department of Agriculture, indicate that anhydrous milk fat from fresh cream or fresh butter may be safely stored without refrigerationfor from 2 to 3 months at 98.6° F. (37°C.). However, refrigeration of the anhydrous milk fat assures the maintenance of top quality.

In preparing fluid skim milk, it is only necessary to replace the water that has been removed in the preparation of nonfat dry milk solids. In preparing fluid whole milk, it is only necessary to add liquid milk fat to the previously reconstituted nonfat dry milk solids and to homogenize this recombined product. A chocolate skim milk drink may be prepared by adding chocolate powder, stabilizer, and sugar in the desired quantities to reconstituted fluid skim milk. Chocolate milk may be prepared by adding liquid milk fat to the mixture of cocoa, sugar, and skim milk, and then homogenizing.

Tables 1 and 2 give the quantities of ingredients required to produce specific recombined products. These tables serve only as examples, and in any product the content of nonfat solids and fat may be varied to fulfill special requirements.

It is essential that a palatable, safe water supply be available for the preparation of recombined dairy products.

II. Instructions for Preparation

Skim Milk

To prepare fluid skim milk, the nonfat dry milk solids are added to the proper quantity of water, which has previously been heated to at least 100°F. (37.8°C.). The water should be agitated during the addition of the powder and until the powder is completely dissolved. A small quantity of salt may be added to enhance the flavor of the product. The mixture should then either be heated to at least 143°F. (61.7°C.) for at least 30 minutes, or passed through a High-Temperature-Short-Time pasteurizer, which holds it at a temperature of not less than 161°F. (71.7°C.) for at least 15 seconds. After pasteurizing, the product should be cooled immediately to at least 40°F. (4.4°C.)

TABLE 1.--Ingredients required to make 1,000 kilograms (2,205 pounds) of recombined products

Product	Water				Nonfat dry milk solids		Anhydrous milk fat		Cocoa powder[1]		Sugar		Salt	
	Liters	*Gallons*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Ounces*
	PLAIN MILKS													
Skim milk	910	240.8	910	2,006	90	198	--	--	--	--	--	--	625	22
Milk:														
2.5% fat	885	234.2	885	1,951	90	198	25	55	--	--	--	--	625	22
3.0% fat	880	232.9	880	1,940	90	198	30	66	--	--	--	--	625	22
3.5% fat	875	231.6	875	1,929	90	198	35	77	--	--	--	--	625	22
	CHOCOLATE-FLAVORED MILKS[2]													
Chocolate skim milk	845	223.7	845	1,863	90	198	--	--	15	33	50	110	1,000	35
Chocolate drink:														
1% fat	835	221.0	835	1,841	90	198	10	22	15	33	50	110	1,000	35
2% fat	825	219.6	825	1,819	90	198	20	44	15	33	50	110	1,000	35

[1] If the cocoa powder does not contain a stabilizer, from 0.2 to 0.3 percent, or 2-3 kilograms, of sodium alginate, Irish moss, or a similar product should be added as an ingredient for each 1,000 kilograms of finished product.

[2] The quantities of cocoa and sugar may be varied.

TABLE 2.--Ingredients required to make 1,000 kilograms (2,205 pounds) of recombined ice cream mix[1]

Product	Water				Nonfat dry milk solids		Anhydrous milk fat		Sugar		Stabilizer	
	Liters	*Gallons*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*	*Kilograms*	*Pounds*
Ice cream (10% fat, 11% nonfat dry milk solids)	637	168.3	637	1,404.5	110	242	100	220	150	330	3	6.6
Ice milk:												
6% fat, 12% nonfat dry milk solids	667	176.2	667	1,470.7	120	264	60	132	150	330	3	6.6
3% fat, 13% nonfat dry milk solids	687	181.7	687	1,511.4	130	286	30	66	150	330	3	6.6

[1] Add salt to the 10% mix in the same proportion as for chocolate milk; add approximately 2% cocoa to produce a chocolate product; add vanilla flavoring in accordance with type and strength available.

Whole Milk

To prepare fluid whole milk, the nonfat dry milk solids are dissolved in water as outlined under "Skim Milk," above. The anhydrous milk fat is heated until it is in a liquid state. This liquid is then added to the skim milk while the skim milk is being agitated. When the milk fat is added to the skim milk, the temperature of the skim milk should be at least 115°F. (46.0°C.), and that of the milk fat should be lower.

The milk fat and skim milk are then thoroughly mixed and the temperature of the mixture raised to at least 145°F. (62.8°C.). A small quantity of salt may be added to enhance the flavor of the product. The mixture may be pasteurized either by holding it at not less than 143°F. (61.7°C.) for not less than 30 minutes or by passing it through a High-Temperature-Short-Time pasteurizer at not less than 161°F. (71.7°C.) for not less than 15 seconds, and then homogenized; or it may be homogenized immediately after the temperature of 145°F. (62.8°C.) has been reached. In either instance, the mixture is homogenized at 2,000-2,500 pounds' pressure. If not pasteurized prior to homogenization, the recombined milk should be immediately pasteurized afterward. The final step is to cool the milk immediately to 40°F. (4.4°C.).

Chocolate Skim Milk

To prepare chocolate skim milk the skim milk is recombined as outlined. The dry cocoa powder, stabilizer (sodium alginate), sugar, and salt are mixed and added to the skim milk, which should be at a temperature of at least 158°F. (70°C.). After the added ingredients are dissolved, the product is pasteurized and cooled as previously outlined. Fat may be added to this product to produce a chocolate milk, and the quantities of cocoa and sugar used may be varied. If fat is added, the appropriate procedure as outlined under "Whole Milk" should be followed.

Ice Cream

To prepare ice cream, the nonfat dry milk solids and milk fat are recombined as for whole milk and the temperature raised to 158°F. (70°C.). The sugar, stabilizer, and cocoa (if chocolate ice cream is being made) are then added and the temperature raised for pasteurization to not less than 161°F. (71.7°C.) and held for not less than 30 minutes. The mix is then homogenized at the pasteurization temperature in accordance with the instructions of the manufacturer of the homogenizer used; cooled to at least 40°F. (4.4°C.); and frozen within 24 hours. The amount of air incorporated during freezing (overrun) may be varied from 80 percent to 100 percent in accordance with the desired texture. The frozen ice cream should then be hardened at 0° to -10°F. (-17.8°C. to -23.3°C.). The lower temperature is desirable.

III. Approximate Cost of Plant Installations

The total cost of each installation is determined by local conditions. Basic pieces of equipment are essential for each installation, but often the adaptation of the equipment to an available building and the availability of utilities (water and electric power) will affect the total cost of an installation.

It is suggested that each installation be based on one of the models listed below:

Plant	Production capacity per 8-hour day		Estimated total cost of plant, machinery, and equipment[1]
	Milk	Ice cream	
	Gallons	*Gallons*	
A------------	1,000	400	$90,000-$125,000
B------------	3,000	1,200	140,000- 170,000
C------------	10,000	4,000	([2])

[1] Delivered to plant location in foreign country.
[2] To be calculated for each individual plant.

The total cost of establishing any one of the above plants would include an amount for engineering, procurement, shipment, installation, and other attendant costs, as well as the initial purchase price of the equipment. The total costs indicated do not include an amount for the duties, tariffs, or taxes that might be imposed by the government of the country in which the plant is to be installed.

Each plant should be engineered as a separate unit, to meet local conditions.

The lists of essential equipment presented in tables 3 and 4 give sizes and general types for Plants A and B (the 1,000-gallon and 3,000-gallon base plants). These lists, which are not offered as complete lists of required equipment but are suggested as guides only, take into consideration various types of operations. Individual requirements will depend upon the products desired, the type of packaging, and so on. Each table covers but one plan for installing the plant. The weights and cubic capacities are approximate.

Large plants like Plant C require additional engineering, so that the various pieces of equipment can be properly integrated and coordinated, and so that a building can be constructed that is of the proper size and design to make the resulting operations economical. The total cost of machinery and equipment for such a plant should be calculated for each location, in order to satisfy requirements and conditions peculiar to the area.

TABLE 3.--Equipment for Plant A (producing 1,000 gallons of milk and 400 gallons of ice cream per 8-hour day)

Type of equipment	Number needed	Capacity	Approx. weight per unit	Approx. size
			Pounds	*Cu. ft.*
Pasteurizing vat (air space heater, indicating and recording thermometer).	[1] 2	200 gals.	2,000	125
Homogenizer (including motor, starter controls, etc.)	1	350 gals./hr.	1,800	65
Milk cooler (cooling water calculated at 80°F.)	1	3,000 lbs./hr.	600	30
Blender pump (for reconstitution; includes funnels, etc.).	1	--	100	30
Milk pump, regular centrifugal	1	--	50	10
Tank (level or surge, uninsulated)	2	200 gals.	500	125
Filler for--				
Paper bottles[2]	1	20-24 qts./min.	1,500	30
Glass bottles (stainless steel with float)[3]	1	36 qts./min.	2,000	100
Cases (wooden or metal) for--				
Paper bottles[2]	1,200	20 qts./case	--	--
Glass bottles[3]	2,000	12 qts./case	--	--
Bottles:				
Paper (quart and pint sizes as needed to maintain essential inventory).[2]	--	--	--	--
Glass (7-day supply)[3]	28,800	--	--	--
Bottle washer (6 bottles wide)[3]	1	24/min.	4,800	360
Wash sink and rack (10-ft. unit with power turret)	1	--	500	72
Platform scale	1	--	50	20
Steam generator, 50 h.p. (including special export parts kit and assembly for metering chemical treatment into feed water).	1	--	4,000	200
Refrigeration unit (for milk cooling only)	1	10 tons	3,000	160
Individual refrigerated box, 12'x12' (for storage of milk at 35°F.).	1	--	1,000	200
Individual low-temperature box, 12'x12' (including thermobank and condensing unit; for refrigerated storage of ice cream at 0°F.).	1	--	1,000	200
Ice cream freezer, batch, direct expansion	1	40 qts.	1,000	40
Compressor, self-contained, for ice cream freezer	1	--	3,000	75
Ice cream cup filler, automatic	1	--	750	72

[1] To facilitate operation, more than 2 pasteurizing vats may be necessary.
[2] For plants using paper bottles.
[3] For plants using glass bottles.

Note.--Plant capacity can be more than doubled by operating on multiple shifts. Ample time for cleaning and sanitizing must, however, be allowed in each 24-hour period. In addition to the above equipment, the plant should have appropriate watertreating equipment, sanitary lines and fittings, steam and water lines, power and light wiring (with conduit, switches, etc.), and sewage disposal facilities. If an adequate supply of electric power and water is not readily available, provision should be made for the installation of wells, pumps, and electric power generating equipment, together with storage tanks for water and fuel. A list of equipment needed for a laboratory is available on request.

TABLE 4.--Equipment for Plant B (producing 3,000 gallons of milk and 1,200 gallons of ice cream per 8-hour day)

Type of equipment	Number needed	Capacity	Approx. weight per unit	Approx. size
			Pounds	*Cu. ft.*
Pasteurizing vat (air space heater, indicating and recording thermometer).	[1] 2	500 gals.	4,000	150
Homogenizer (complete with motor)	1	500 gals./hr.	3,600	80
Milk cooler	1	6,000 lbs./hr.	650	40
Blender pump (for reconstitution; includes funnels, etc.).	1	--	100	30
Milk pump, regular centrifugal	1	--	50	10
Tank (level or surge, uninsulated)	2	300 gals.	1,000	200
Filler for--				
Paper bottles[2]	1	35 qts./min.	1,500	30
Glass bottles (stainless steel with float)[3]	1	60 qts./min.	2,000	150
Cases (wooden or metal) for--				
Paper bottles[2]	3,000	20 qts./case	--	--
Glass bottles[3]	5,000	12 qts./case	--	--
Bottles:				
Paper (quart and pint sizes, as needed to maintain essential inventory).[2]	--	--	--	--
Glass (7-day supply)[3]	72,000	--	--	--
Bottle washer (8 bottles wide)[3]	1	60/min.	6,200	420
Wash sink and rack (10-ft. unit with power turret)	1	--	500	72
Platform scale	1	--	50	20
Steam generator, 100 h.p. (including special export parts kit and assembly for metering chemical treatment into feed water).	1	--	8,000	400
Refrigeration unit for milk cooling	2 (or eq. cap.)	10 tons	3,000	160
Individual refrigerated box, 30'x30' (for storage of milk at 35°F.; box, blower, and condensing unit included).	1	--	3,000	500
Individual low-temperature box, 12'x12', with accessories (for refrigerated storage of ice cream at 0°F).	1	--	1,000	200
Ice cream freezer, batch, direct expansion	2	40 qts.	1,000	40
Compressor, self-contained, for ice cream freezer	2	--	3,000	75
Ice cream cup filler, automatic	1	--	750	72

[1] To facilitate operation, additional pasteurizing vats may be necessary.
[2] For plants using paper bottles.
[3] For plants using glass bottles.

Note.--Plant capacity can be more than doubled by operating on multiple shifts. Ample time for cleaning and sanitizing must, however, be allowed in each 24-hour period. In addition to the above equipment, the plant should have appropriate watertreating equipment, sanitary lines and fittings, steam and water lines, power and light wiring (with conduit, switches, etc.), and sewage disposal facilities. If an adequate supply of electric power and water is not readily available, provision should be made for the installation of wells, pumps, and electric power generating equipment, together with storage tanks for water and fuel. A list of equipment needed for a laboratory is available on request.